City of Bellevue

West Operating Area Capacity Improvement Study

DECEMBER 2010

RH2 Engineering, Inc.
12100 NE 195th Street, Suite 100
Bothell, WA 98011

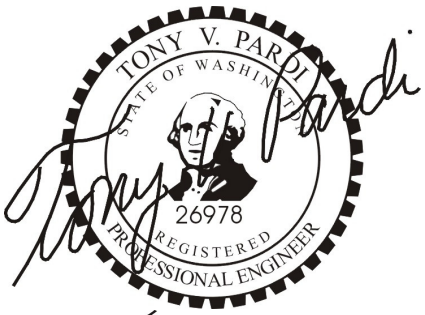
City of Bellevue

West Operating Area Capacity Improvement Study

The information contained in this report was prepared by and under the direct supervision of the undersigned.

Richard H. Harbert, P.E.

President



Tony V. Pardi, P.E.

Vice President

City of Bellevue
West Operating Area Capacity Improvement Study
Table of Contents

TABLES

APPENDICES

City of Bellevue
West Operating Area Capacity Improvement Study

INTRODUCTION

The objective of this report is to document the criteria and methods used in the reservoir site selection study for the City of Bellevue's (City) West Operating Area and to summarize the hydraulic analyses for sizing related improvements. The study includes review of parcels in the West Operating Area and evaluation of viable sites for constructing necessary storage capacity to serve the West Operating Area. Preliminary site plans and life cycle cost analyses for each improvement are included as part of this report.

EXECUTIVE SUMMARY

This report analyzes and identifies planning-level storage improvement solutions to resolve the long-term storage deficiency of 6.5 million gallons (MG) within the West Operating Area. The results of this study will be utilized by the City to prepare for acquisition of new property or to reserve City-owned property for construction of future storage facilities. The study will also provide the City with a framework for predesign and design of the storage facilities and related improvements.

Existing reservoir sites, undeveloped publicly owned parcels and other undeveloped spaces within the West Operating Area were evaluated to determine potentially viable sites for the proposed West Operating area storage. 435 individual parcels were evaluated, and each was assigned a rating based on criteria developed by the City and RH2 Engineering, Inc. (RH2).

Preliminary hydraulic analyses were performed to complement the parcel evaluation and to determine hydraulically-viable reservoir sites. Results of the parcel rating and preliminary hydraulic analyses were presented to the City in a meeting on March 17, 2010. The City conducted internal meetings with the Parks Department and other City staff to identify four preferred sites for more detailed evaluation by RH2. Based on the results of these discussions, the City selected the following sites for further analysis:

1. Meydenbauer Reservoir site
2. Pike's Peak Reservoir site
3. Watershed Park in Kirkland
4. Woodridge Reservoir site

For the four reservoir sites selected by the City, more detailed analyses were performed. Site reconnaissance was performed and geological and environmental conditions, preliminary permitting requirements, planning-level cost estimates and life-cycle costs were reviewed and documented. For each site, a predetermined list of criteria was evaluated.

In order to meet projected demands, the City prefers to construct a portion of the required 6.5 MG of storage prior to 2014, and to construct the remaining storage at a separate site as populations and demands increase throughout the West Operating Area. Preliminary hydraulic analyses were performed for each site to identify planning-level water system improvements.

Locating all 6.5 MG of storage at a single site would require significant capital and maintenance expenditures that are not projected to be necessary until at least 2030. Locating the additional storage at two sites as part of a phased approach gives the City the flexibility to accelerate or delay the second phase to better accommodate future demands. Additional hydraulic analyses were performed to identify planning-level water system improvements for construction of a second reservoir to ensure adequate water supply to the Bellevue 400 Zone for peak year 2050 demand conditions.

The four reservoir sites and their associated improvements were evaluated to determine the most favorable reservoir sites. Site ranking criteria were applied to each reservoir site. The criteria encompass nine different categories, with a weighting factor assigned to each. Capital and life cycle costs were estimated for a new 3.5 MG Meydenbauer Reservoir, replacing the existing 1.0 MG Pike's Peak Reservoir with a 4.5 MG reservoir (3.5 MG of additional storage), a new 3.5 MG Watershed Park Reservoir and replacing the existing 2.0 MG Woodridge Reservoir with a 5.5 MG reservoir (3.5 MG of additional storage). The criteria given highest weighting were net cost, vulnerability to natural hazards and impacts to system hydraulics. A summary of the weighted point totals, estimated capital costs and estimated net present value of the life cycle costs for each site, based on a 3.5 MG net increase in storage, is shown in **Table EX1**.

Table EX1
Proposed Reservoir Sites Summary

Description	Meydenbauer	Pike's Peak	Watershed Park	Woodridge
Life Cycle Cost[1]	$16,048,000	$8,860,000	$9,242,000	$13,510,000
Initial Capital Cost[1]	$7,892,000	$7,411,000	$8,070,000	$12,612,000
Weighted Point Total	62	80	61	66

(1) Costs presented in 2010 dollars.

Due to the additional costs that would be incurred with the operation, maintenance and ongoing energy costs, the Meydenbauer site was excluded from further consideration. Additionally, due to the uncertainty involved with the terms of a future agreement between the cities of Bellevue and Kirkland to construct a reservoir at Watershed Park, as well as the results of the priority ranking criteria, the Watershed Park site was also excluded from further consideration. The recommended approach is to divide the new 6.5 MG of storage between the Pike's Peak and Woodridge sites.

The existing 1.0 MG Pike's Peak Reservoir can be replaced with a 4.5 MG Reservoir to resolve the projected 2025 storage deficiency and the existing 2.0 MG Woodridge Reservoir can be replaced with a 5.0 MG reservoir to resolve the projected 2050 West Operating Area storage deficiency. For alternative comparison purposes, construction costs were estimated for the proposed 4.5 MG Pike's Peak and 5.0 MG Woodridge Reservoir improvements. The estimated capital cost of the improvements is approximately $18,500,000 in 2010 dollars ($7,300,000 in 2011 for a 4.5 MG Pike's Peak Reservoir and $11,200,000 in 2030 for a 5.0 MG Woodridge Reservoir).

BACKGROUND

Bellevue's 2006 Water Comprehensive Plan (2006 WCP) identified the need for additional storage within the City's West Operating Area. The 2006 WCP identified a West Operating Area storage deficiency of approximately 2.3 MG by 2040. Since completion of the 2006 WCP, the City has adopted a new set of zoning and development guidelines for the Bel-Red Corridor allowing for higher density development, greater environmental sustainability, increased urban land use efficiency, improved economic vitality and the addition of large-scale transit-oriented centers. The City's downtown sub-area is also expected to experience significant continued development. The West Operating Area, Bel-Red Corridor and Central Business District boundaries are shown in **Figure 1**.

To accommodate the new Bel-Red Corridor development and downtown growth, the City has refined the storage capacity need for the West Operating Area. Recent estimates project that the West Operating Area will have a storage deficiency of approximately 6.5 MG by 2050. If current growth projections are realized, approximately 1.5 MG of this storage will be needed by 2014.

PURPOSE

The purpose of this study is to analyze and identify storage improvements to resolve long-term storage deficiency within the West Operating Area. As part of this study, existing and potential reservoir sites were evaluated, the option to replace existing, aging facilities with new, larger capacity reservoirs was considered. To assist in the selection of viable alternatives, analyses of benefits, risks and life cycle costs were performed. The results of this study will be utilized by the City to prepare for acquisition of new property or to reserve City-owned property for construction of future storage facilities. The study will also provide the City with a framework for predesign and design of the storage facilities and related improvements.

STORAGE REQUIREMENTS

The City's existing West Operating Area is shown in **Figure 1**. A hydraulic profile of the system, which demonstrates how water supply is conveyed throughout the West Operating Area, is shown in **Figure 2**. The combined existing storage capacity of the 8 reservoirs that serve the West Operating Area is 13.45 MG.

The City has performed future reservoir sizing analyses for the system through 2050. The results of these analyses, shown in **Table 1**, indicate a West Operating Area storage deficiency of 6.5 MG by 2050. The schedule shown in the table below will be utilized to identify improvement solutions to increase the storage capacity of the system before the need arises. Alternatives to be considered include phased construction of multiple reservoirs at selected sites to accommodate future growth as it is expected to occur, replacement of existing, aging facilities with new, larger reservoirs or construction of a single new reservoir to meet the total projected storage need.

Table 1
Future Storage Requirement Schedule

Year	Additional Storage Required		
	Downtown (MG)	Bel-Red Corridor (MG)	Total (MG)
2014	1.0	0.5	**1.5**
2020	0.5	0.5	**1.0**
2025	0.5	0.5	**1.0**
2030	0.5	0.5	**1.0**
2035	0.5	0.5	**1.0**
2040	---	0.5	**0.5**
2050	---	0.5	**0.5**
Total	**3.0**	**3.5**	**6.5**

VIABLE SITE IDENTIFICATION

Preliminary evaluation of existing and potential new reservoir sites was conducted to develop a list of potentially viable sites for reservoir construction. The desktop evaluation reviewed existing reservoir sites, undeveloped publicly-owned parcels and other undeveloped spaces within the West Operating Area to identify viable sites for further consideration. Evaluation was based on the City's GIS data and other publicly-available information. Government-owned and vacant parcels were identified from a GIS file originally created by the City in 2006 and updated in January 2010.

All parcels within the West Operating Area which are government-owned, vacant and privately owned, or City-owned existing reservoir sites are shown in **Figure 3**. Aerial photos as well as City and County's GIS data were reviewed to assign a rating to each of these sites based on the criteria below. A one to five point system was used to rank the sites; higher ranked sites were assigned a higher point value. Four-and five-point-rated sites were flagged for further consideration.

- If the parcel is currently owned by the City and is used for water storage, the parcel was assigned five points and was considered for further investigation.
- If the parcel is fully-developed or fully-utilized (for instance, baseball or soccer fields covering an entire parcel), the parcel was assigned one point and no further investigation took place for the parcel.
- If the parcel is located within a wetland, it was assigned one point and no further investigation took place for the parcel.
- If a nearby water body or watercourse significantly restricts the amount of land available for a reservoir, the parcel was assigned two points and no further investigation took place for the parcel.

- If the parcel is not large enough to contain at least a 2.50 MG reservoir, it was assigned three points and no further investigation took place for the parcel. The reservoir capacity was based on the following calculations:
    - The parcel's smallest dimension (length or width)
    - A maximum reservoir diameter equal to half of the parcel's smallest dimension
    - The reservoir was assumed to be circular or relatively square. Long narrow sites and reservoir shapes were not considered.
    - The maximum reservoir height is 30 feet
- Of the parcels with enough area to contain a 2.50 MG or larger reservoir, those parcels that were located below 300 feet in elevation were assigned four points, and those that are located at elevations higher than 300 feet were assigned five points.

The 300-foot-elevation criterion was established to differentiate the four-and five-star-rated sites. This is the lowest elevation that is feasible for constructing a reservoir to serve the City's 400 Pressure Zone by gravity. The City prefers to limit the reservoir height to 25-30 feet within residential neighborhoods. The 300 foot elevation threshold was chosen in order to include potential sites that may be suitable for a taller reservoir. Accuracy of the available elevation data can vary by as much as 20-30 feet. Reservoirs constructed at elevations lower than 300 feet will require a new booster pump station to pump water from the facility into the 400 Zone to serve the Bel-Red Corridor and the Central Business District.

Developed sites, wetlands and sites without sufficient space to accommodate at least a multi-million-gallon reservoir were not considered further. Desirable characteristics used to identify sites for further evaluation include:

- Sufficient elevation for gravity flow from the reservoir to the 400 zone without the need for pumping
- Sufficient existing hydraulic connectivity to the 400 zone for water turnover during periods of low demands and the prevention of water stagnation
- Existing water storage reservoirs on the site

A first-round evaluation was performed on 435 individual parcels. Of the 76 sites that met the development, environmental and size criteria, 10 were identified for further evaluation based on their desirable characteristics. A summary of the sites that were reviewed is shown in **Appendix D** and mapped in **Figure 3**.

Preliminary Hydraulic Analyses

Additional analyses were performed to complement the parcel evaluation and to determine hydraulically-viable sites. A hydraulic model obtained from the City was utilized for these analyses. Build-out water system demands were identified from the EPANET model of the existing West Operating Area. The model was converted to WaterCAD and an evaluation of the demand distribution was conducted. Future build-out demand projections by the City for each pressure zone in the West Operating Area are shown in **Table 2**.

Table 2
West Operating Area Buildout Demand by Pressure Zone

Pressure Zone	Demand (gpm)	Demand (% of total)
Bellefield 220 Zone	1,001	6.9%
Yarrow Bay 220 Zone	20	0.1%
Medina 230 Zone	11	0.1%
Hunts Point 250 Zone	39	0.3%
Meydenbauer 252 Zone	962	6.6%
Enatai 300 Zone	418	2.9%
Kelsey Creek 300 Zone	134	0.9%
Clyde Hill 335 Zone	786	5.4%
Bellevue 400 Zone	9,586	65.9%
Woodridge 400 Zone	140	1.0%
Woodridge 450 Zone	385	2.6%
Clyde Hill 500 Zone	334	2.3%
Pikes Peak 550 Zone	358	2.5%
Pikes Peak 600 Zone	67	0.5%
Pikes Peak 670 Zone	312	2.1%
Totals	**14,553**	**100.0%**

By the time the system reaches build-out, nearly two-thirds of the total demand in the West Operating Area is projected to be located within the Bellevue 400 Zone, which serves the Bel-Red Corridor and the Central Business District. A small portion of the Central Business District is also served by the Bellefield 220 Zone. The majority of existing storage capacity is located in the Bellevue 400 Zone and the build-out demand distribution indicates that this should remain the case in the future. As a result, standby and emergency storage will remain within close hydraulic proximity making stored water readily available to the new development anticipated within the Bel-Red Corridor and the Central Business District. Viable sites located within or near the Bel-Red Corridor and the Central Business District were identified as hydraulically preferable.

Given the large percentage of demand anticipated in the Bellevue 400 Zone, hydraulic analyses were performed to evaluate the system's ability to maintain the hydraulic gradient in all portions of the zone. Analyses indicate that the highest hydraulic grade occurs in the eastern portion of the zone and generally decreases towards the southwest. During a peak day demand scenario, the majority of the zone maintains a minimum hydraulic grade of 388 feet; however, the gradient degrades significantly in areas of the zone located south of Main Street and west of 112th Avenue NE. In these areas, the hydraulic gradient ranges from a low of 324 feet near the Meydenbauer Reservoir to 370 feet along 112th Avenue NE, south of Main Street. Analyses indicate that this portion of the pressure zone would benefit from a facility which maintains the hydraulic grade. Two alternatives for maintaining hydraulic grade include adding a reservoir or booster station, and/or installing water main improvements to draw the area hydraulically closer to existing facilities that establish the

hydraulic gradient in the zone. Therefore, the viable sites located within the Bellevue 400 Zone south of Main Street and west of 112th Avenue NE are more hydraulically optimal.

Redirecting existing under-utilized storage from other pressure zones to the 400 Zone was also considered. Under this scenario, new storage facilities would be constructed within the Enatai 300 or Clyde Hill 335 Zones and directed to the 400 zone. However, no viable alternatives were found for this scenario.

Preliminary Site Selection

The results of the parcel rating and preliminary hydraulic analyses were presented to the City in a meeting on March 17, 2010. The highest-rated parcels, with an emphasis on those located in hydraulically optimal locations, were discussed. The City expressed a preference to limit reservoirs in residential areas to a 30-foot maximum height. Sites with existing elevated storage or those locations outside of residential areas were assigned a higher rating.

Based on the meeting discussion, the following sites were selected for further evaluation. A brief summary of each follows.

Viewpoint Park

Viewpoint Park is located between SR 520 and NE 24th Street at 134th Avenue NE. The location of the park adjacent to SR 520 may alleviate permitting concerns for an elevated storage facility. The approximate ground elevation ranges from 300 feet to 325 feet, making it feasible to provide gravity storage to the Bellevue 400 Zone from this site if a tall reservoir were constructed. The site is currently owned by the City's Parks Department and has sufficient open space to accommodate a 6.5 MG reservoir, if needed.

Because of this site's proximity to supply inlets, it may be difficult to obtain adequate turnover during periods of low demands. This could be resolved via construction of new transmission main or with the redevelopment of the Bel-Red Corridor. Olympic Pipeline and Puget Sound Energy operate on easements within the park. Because a higher, non-park site, 2402 134th Avenue NE, is located nearby, Viewpoint Park was dropped from further consideration.

Clyde Hill 335 Round Reservoir site and adjacent property

The existing Clyde Hill 335 Round and Square Reservoirs could be replaced with a larger reservoir, making that site a candidate. A new reservoir at this site has the potential for being a taller structure due to adjacent non-residential properties. This site is ideally located within close proximity to the Central Business District, near the intersection of NE 16th Street and 97th Avenue NE.

The existing Clyde Hill 335 Round Reservoir site and the parcel immediately east of the site have an approximate ground elevation of 305 feet. The sites are located in the Town of Clyde Hill. Increasing 335 Zone storage at this site would not benefit the 400 Zone, therefore the Clyde Hill 335 site was dropped from consideration.

12300 Main Street

This site is reasonably close to the Bel-Red and downtown areas and is large enough to construct a several-million gallon reservoir. However, the ground elevation is approximately 200 feet and pumping would be required in order to serve the 400 Zone. Additionally, the current owner, the

Bellevue School District, is not interested in selling the property. The 12300 Main Street site was dropped from further consideration.

Cherry Crest Reservoir

The Cherry Crest reservoir site is located at an approximate elevation of 400 feet. The existing reservoir on this site is fairly new and encompasses the majority of the site. There are difficulties using the existing storage capacity because of water quality concerns. The Cherry Crest Reservoir site was dropped from further consideration.

2402 134th Avenue NE

The ground elevation at this site ranges from approximately 340 feet to 360 feet. A tank located on this site would likely need to be at least 40 feet tall. The Cherry Crest Inlet is between this site and the 400 zone. It would be difficult to provide adequate water turnover in a reservoir at this site during periods of low demands. Therefore, the 2402 134th Avenue NE site was dropped from further consideration.

Watershed Park, Kirkland

The southeastern corner of Watershed Park, located in southern Kirkland, immediately west of Interstate 405, has a ground elevation between 360 and 390 feet. Although it is somewhat distant from the high-demand areas of downtown Bellevue and the Bel-Red corridor, it is close to the northern boundary of the 400 pressure zone. This area of Watershed Park was used as a quarry when Interstate 405 was constructed. The area cleared for the quarry could support a 6.5 million gallon reservoir that could feed the 400 Zone by gravity. Bellevue would need to negotiate purchase of this site from the City of Kirkland.

Woodridge Reservoir site

The existing 2.0 MG Woodridge Reservoir is a 73-foot-tall structure that serves the Bellevue 400 Zone. The reservoir is located on SE 20th Street at approximately 124th Avenue SE. The approximate ground elevation of the site is 320 feet and it is currently owned by the City's Utilities Department.

The Woodridge Reservoir site has available area to accommodate up to 5.5 MG of additional storage if the existing reservoir were demolished. Constraints associated with permitting can be vetted during the predesign phase to more accurately determine the maximum capacity that can be constructed on this site. Currently there is one transmission main that connects the Woodridge site to the demand centers of the Bellevue 400 Zone. Redundancy in transmission main capacity should be considered for this site. Puget Sound Energy operates on an easement at the site.

Meydenbauer Reservoir site

The existing Meydenbauer Reservoir site has sufficient open space to allow construction of a new 4.0 MG reservoir, if needed. The site is located on 96th Avenue SE at approximately SE 6th Street and is currently owned by the City's Utilities Department. Its ground elevation is approximately 252 feet. Therefore, a new booster pump station would be required to convey storage into the Bellevue 400 Zone.

This site is located in a hydraulically-optimal location, however, new transmission main would be necessary to convey supply to this location. It may be possible to convert the existing transmission main in the Meydenbauer 252 Zone to the Bellevue 400 Zone for this purpose.

Pike's Peak Reservoir site

The existing 1.0 MG Pike's Peak Reservoir is a 24-foot-tall, 85-foot-diameter structure that serves the Pike's Peak 550 Zone. The site is located on the southern boundary of Bridle Trails State Park (Bridle Trails) and can be accessed from NE 39th Street via an existing water utility easement.

There is sufficient area available adjacent to the Pike's Peak Reservoir to construct a 6.5 MG reservoir, if needed. If this site is selected, the City prefers to demolish the existing reservoir and construct a new, larger reservoir in its place. Currently there is one transmission main that connects the Pike's Peak Reservoir site to the demand centers of the Bellevue 400 Zone. A new transmission main would be required to convey supply to the Bellevue 400 Zone. The ground elevation of the site is approximately 530 feet and it is owned by the Washington State Parks Department. Seattle City Light operates within an easement in Bridle Trails.

Bel-Red Redevelopment Area

The industrial area along the Bel-Red Corridor will likely be completely redeveloped with the City's adoption of new zoning and development guidelines for the area. A new reservoir could be sited within this area, however, it is difficult at this time to identify specific sites as redevelopment planning has not yet begun. As development occurs, the City would need to coordinate with developers to purchase property to accommodate a new reservoir with a capacity of up to 6.5 MG.

Although this area is located near high-demand centers, ground elevations range from approximately 150 to 200 feet and would require construction of a new booster pump station to convey storage to the Bellevue 400 Zone.

Parks in the 400 Zone

Several Bellevue parks in or near downtown could potentially accommodate a new storage facility. These parks include Bovee Park, Wilburton Park, Hidden Valley Sports Park, Kelsey Creek Park, Killarney Glen Park and the Chapin property. These sites are all currently owned by the City's Parks Department.

Review of these sites showed that the Parks Department was either planning to develop the areas that would be suitable for a reservoir and/or that these areas were highly valued as natural, undeveloped areas. Each of these park areas would require construction of an adjacent pump station to deliver the water from the reservoir to the 400 zone. Consequently, these park areas were dropped from consideration.

Site Selection Conclusion

The City conducted internal meetings with Parks Department and other City staff to identify four preferred sites for further detailed evaluation by RH2. Coordination with the Olympic Pipeline Company and Puget Sound Energy was also completed to identify any constraints for easements on the Woodridge and Viewpoint Park sites. Based on the results of these discussions, the City selected the following sites for further analysis:

1. Meydenbauer Reservoir site
2. Pike's Peak Reservoir site
3. Watershed Park in Kirkland
4. Woodridge Reservoir site

SITE EVALUATION

For the four reservoir sites selected by the City, more detailed analyses were performed. A site reconnaissance was performed and geological and environmental conditions, preliminary permitting requirements, and planning-level cost estimates were also reviewed and documented.

For each site, the following criteria were evaluated:

- Proximity to an ideal ground elevation
- Construction access
- Operations and maintenance access and needs
- Location of adjacent structures
- Availability of undeveloped space for facility expansion
- Geologic stability of each site and of adjacent parcels
- Presence of critical areas including wetlands and streams within each site and on adjacent parcels
- Impact to existing vegetation including hydrophytic plant communities
- Seismic, liquefaction and other natural hazard vulnerability
- Neighborhood impacts including obstructed or otherwise affected views, noise and temporary inconveniences due to construction activities, and temporary or permanent changes in site use
- Impacts to system hydraulics
- Benefit to system reliability
- Contribution to resolving other water system deficiencies

The City prefers to construct a portion of the required 6.5 MG of storage prior to 2014, and to construct the remaining storage at a separate site as population and demands increase. Preliminary hydraulic analyses were performed for each site to identify necessary improvements. The objective is to add a single new reservoir to meet existing average day demands within Bellevue's 400 pressure zone. Additional hydraulic analyses were performed to identify future improvements for a second reservoir, to be constructed at a later date, to ensure adequate water supply to the Bellevue 400 Zone in peak year 2050 demand conditions as shown in **Table 2**. The hydraulic analyses considered balancing flow provided from existing reservoirs under to ensure sufficient utilization of the new storage capacity. Water system improvements identified to achieve this are shown schematically on

Figure 4 and include pump stations, additional transmission main capacity and pressure reducing valve stations.

Meydenbauer Reservoir Site

Background

The existing 1.2 MG Meydenbauer Reservoir provides water storage to the City's 252 Zone and is located in a single family residential neighborhood west of Interstate 405. The reservoir was constructed in 2004. An additional reservoir could be constructed on the flat, grassy area immediately south of the existing reservoir. The Meydenbauer Reservoir site and the proposed reservoir site to the south were visited by RH2 on July 8, 2010. Notes and photos from the site reconnaissance are shown in **Appendix D** and the favorable proposed reservoir location is shown in **Figure 5**.

Site Access

The Meydenbauer Reservoir site can directly and easily be accessed via the east side of the parcel from 96th Avenue SE. Favorable access for construction of a proposed reservoir, as well as operation and maintenance of the reservoir, is viable from this location which is approximately 150 feet north of the intersection of SE 7th Street and 96th Avenue SE. The proposed site access locations are shown in **Figure 5**.

Adjacent Structures

The existing Meydenbauer Reservoir is located north of the proposed reservoir location. Single family residences are located on parcels adjacent to the proposed reservoir site, with some residences within 100 feet of the proposed reservoir site. There are no existing structures at the location of the proposed reservoir.

Topography and Capacity Availability

The Meydenbauer Reservoir site is flat on a broad summit with steeply sloping sides on parcels to the northeast. Part of the site has been previously excavated, based on Light Detection and Ranging (LiDAR) imagery, and was graded in 2004 as part of the Meydenbauer Reservoir Replacement Project. The existing ground elevation at the proposed reservoir site ranges from 246 feet to 262 feet. There are no restrictions on the reservoir height as the water will need to be pumped to serve the 400 zone. Ground elevations were identified by plans for the Reservoir Replacement Project and should be confirmed during predesign. Approximately 4.0 MG of storage can be constructed on this site; possibly more. This will be impacted by permitting constraints such as setbacks, landscaping requirements, and neighborhood mitigation requirements. These constraints can be more fully vetted during a predesign phase.

Geology

The Meydenbauer Reservoir site is mapped by the United States Geological Survey (USGS) as glacial till. A previous report, *Seismic Geotechnical Services*; HWA, 1995, included one deep boring to 61 feet below ground surface (BGS), two test pits to 11 feet BGS, one hand auger boring to 4 feet BGS to inspect soil, and included 15-foot BGS soil borings from previous investigations.

An additional report, *Geotechnical Report, Meydenbauer Reservoir Replacement*; GeoEngineers, 2003, included four geotechnical borings from 21 to 46 feet BGS and three environmental borings to 21 feet BGS. The soil borings encountered dense fine sand and silt, and stiff silt and clay, interpreted by GeoEngineers as over-consolidated glacio-lacustrine sediment, rather than glacial till.

Slopes

There is no field evidence of slope instability (steep slopes, ground cracks or tilted vegetation) at the proposed reservoir site. HWA and GeoEngineers concluded the proposed reservoir site is at low risk for onsite slope failure but identified potential risks downslope should soils become saturated by excess runoff or reservoir release. Onsite slopes are relatively flat, are not susceptible to erosion and have a low potential for flooding.

No steep slopes or slope breaks are apparent in LIDAR imagery except to the northeast of the Meydenbauer Reservoir parcel.

Soils and Wetlands

The Meydenbauer Reservoir site is mapped by the Natural Resources Conservation Service (NRCS) as Alderwood soil, derived from glacial till.

The proposed reservoir site is surrounded by erosion-prone soil, as identified by King County's iMAP application (iMAP), although the proposed reservoir parcel itself is not identified as having erosion hazards. The locations of erosion-prone soils near the Meydenbauer Reservoir site are shown in **Figure 5**. No other critical areas were observed during site reconnaissance or are shown at the proposed reservoir site by iMAP.

The National Wetlands Inventory (NWI) and Washington Department of Fish and Wildlife (WDFW) Salmonscape application show no wetlands or streams within or near the proposed reservoir parcel. No wetlands, hydrology or hydrophytic plant communities were evident during the site reconnaissance.

Seismic Vulnerability

HWA and GeoEngineers concluded low risk for ground rupture and liquefaction at the Meydenbauer Reservoir site. The City has mapped the site as low seismic risk and low liquefaction risk.

Vegetation

The proposed reservoir site consists primarily of 4-foot tall grass. Additionally, approximately 30- to 60-foot-tall mature coniferous and deciduous trees are located along the western and southern property lines of the proposed reservoir site. Blackberry bushes are also located along the western property line.

Permits and Approvals

The Meydenbauer parcel is zoned R-1.8 (single family residential estates, 1.8 dwellings per acre). Reservoirs are conditional uses in this zone. A pre-application conference is recommended based on the project's size and proximity to single-family homes. Anticipated permits and approvals include a Conditional Use Permit (Land Use Permit Process I, complete with public meeting and open-record

hearing), building permit, Clearing and Grading, project approval from DOH, State Environmental Policy Act (SEPA) compliance and National Pollutant Discharge Elimination System (NPDES) Phase II and Construction Stormwater compliance. The proposed reservoir site is not located within a section currently identified by the Department of Natural Resources (DNR) as containing natural heritage features.

Neighborhood Impacts

The proposed reservoir site is visible to the adjacent single family residences, including multiple residences facing the proposed reservoir site. There are views of the City's downtown area that will not likely be impacted by a reservoir located at this site, however an above-grade reservoir may be visible throughout the City and surrounding areas.

Temporary construction noise may be audible to the adjacent single-family residences. Construction activities may result in temporarily-obstructed access along SE 7th Street and 96th Avenue SE causing temporary inconveniences to homeowners.

Geological and Environmental Conclusions and Recommendations

The proposed reservoir site's vulnerability to natural hazards is low. The soils at the proposed reservoir site are glacially over-consolidated, are at or near optimum moisture content, contain little or no organic soil, and are likely underlain by thick unsaturated geologic units. Constructability of a reservoir at this site is favorable as a result of these existing soil conditions and should require limited amounts of ground preparation.

The soil at the proposed reservoir site consists of low-permeability glacio-lacustrine soil, resulting in the soil having limited infiltration capacity. As a result, stormwater runoff or reservoir discharge will require conveyance to a nearby stormwater system or relatively large swales.

No geologic or natural hazard site conditions reduce the viability of the site for reservoir construction or operation. However, runoff from the site should be included as a key design element to minimize offsite risk from stormwater runoff or reservoir discharge.

Additional Water System Improvements

Hydraulic analyses were performed to determine the ability of the proposed Meydenbauer Reservoir to operate with the existing water system to ensure adequate water supply can be conveyed from the reservoir to the major demand centers of the Bel-Red Corridor and the Central Business District, which will be located in a different pressure zone. A new reservoir at the existing Meydenbauer Reservoir site will directly serve the Meydenbauer 252 Zone, similar to the current operation of the existing 1.2 MG reservoir. Currently, water supply can be transferred from the Bellevue 400 Zone to the Meydenbauer 252 Zone through various PRVs. However, the system is not capable of transferring water from the Meydenbauer 252 Zone directly back into the Bellevue 400 Zone to provide supply to the Bel-Red Corridor and the Central Business District. To transfer water supply from the 252 zone to the 400 Zone from a new reservoir at the Meydenbauer site, a new 252/400 Zone booster pump station is needed. 485 gpm will turn over the water in a 3.5 MG reservoir in five days. The new booster pump station may be located on the Meydenbauer site and the discharge should be connected to the existing 12-inch Bellevue 400 Zone water main. However, the existing 12-inch water main does not have adequate capacity to convey water supply from the reservoir site to serve the Bellevue 400 Zone. Analyses indicate that the relative hydraulic remoteness of a new

reservoir at the Meydenbauer site to serve the Bellevue 400 Zone may not be fully utilized unless additional improvements are constructed. To make storage at the Meydenbauer site more readily available to the Bel-Red Corridor and the Central Business District, additional transmission main capacity must be provided. Hydraulic analyses were performed to identify planning-level transmission capacity improvements to enhance utilization of a new reservoir at the Meydenbauer site. For the purpose of the analyses, improvements were selected to achieve a minimum discharge rate from the reservoir to achieve complete turnover during periods of low demands in a proposed reservoir at the Meydenbauer site in five days or less. The higher demands in the summer months and other periods of peak demands will result in adequate turnover in all of the existing and proposed West Operating Area reservoirs without further adjustment of the existing control valve set points or throttling of the Bel-Red Intertie.

The planning-level transmission capacity improvements identified from the analyses include the construction of a 12-inch transmission main from the new booster pump station to 4th Street to the existing 12-inch water main adjacent to JC Penney in Bellevue Square. These improvements are shown schematically on **Figure 4**.

The hydraulic analyses performed for the Meydenbauer site indicate that the Clyde Hill 390 Reservoir supplies a significant portion of system demands to the Bellevue 400 Zone because of its relative hydraulic proximity to the demand center of the Central Business District. During summer months, the reservoir level has been observed to fluctuate significantly. To balance the usage of the Clyde Hill 390 Reservoir and a new reservoir at the Meydenbauer site, the Clyde Hill 390 Reservoir operational controls should be adjusted to throttle flow from the reservoir to the Bellevue 400 Zone except under emergency conditions. This will reduce water level fluctuations in the Clyde Hill 390 Reservoir and assist in achieving additional turnover during periods of low demands in a new reservoir at the Meydenbauer site. The proposed 252/400 Zone booster pump station can be equipped in stages with additional pumps, added at later dates, to increase the flow from the reservoir to the Bellevue 400 Zone and to reduce the water level fluctuations in the Clyde Hill 390 Reservoir. Alternatively, more significant water main improvements may be installed from the Meydenbauer site to mimic the Clyde Hill 390 Reservoir's hydraulic proximity to the demand centers and balance the usage of the reservoirs in the Bellevue 400 Zone.

Preliminary Cost Estimate

Project costs for the proposed Meydenbauer Reservoir and other improvements associated with the construction of a reservoir at this site were estimated were estimated based on costs of similar water projects in the Puget Sound area and are presented in 2010 dollars in **Table 3**.

Table 3
Proposed Meydenbauer Reservoir Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
	Construction Costs (2010 $$)				
1	3.5 MG Reservoir	LS	1	$ 2,625,000	$ 2,625,000
2	Site Work and Utilities	LS	1	$ 262,500	$ 262,500
3	Connect to Existing Drainage System	LF	100	$ 160	$ 16,000
4	Booster Pump Station - 800 gpm	LS	1	$ 300,000	$ 300,000
5	12-inch Water Main	LF	6,450	$ 160	$ 1,032,000
	Construction Cost Subtotal				**$ 4,235,500**
	Washington State Sales Tax (9.5 percent)				$ 403,000
	Construction Cost Contingency (20 percent)				**$ 928,000**
	Construction Cost Total				**$ 5,566,500**
	Indirect Costs (2010 $$)				
	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 1,949,000
	Indirect Cost Total				**$ 1,949,000**
	Project Cost Subtotal				$ 7,515,500
	Project Contingency (5 percent)				$ 376,000
	Project Cost Including Construction and Indirect Costs				***$ 7,891,500***

The drainage system infrastructure improvements identified in **Table 3** are recommended for connecting the proposed reservoir drain to the City's existing storm drainage system. Analyses to evaluate the flow capacity requirements for the storm drainage system are beyond the scope of this study.

In addition to the capital costs shown in **Table 3**, the net present value was estimated for the proposed Meydenbauer Reservoir improvements, including booster pump station energy costs, preventative maintenance and reservoir recoating. The estimated net present value of the life cycle cost of the improvements is approximately $16,000,000 in 2010 dollars, as shown in **Appendix B**.

Pike's Peak Reservoir Site

Background

The existing Pike's Peak Reservoir is located on the southern boundary of Bridle Trails, north of SR 520 and east of Interstate 405. Bridle Trails encompasses a forested area of approximately 480 acres within the City of Kirkland. Seattle City Light overhead power transmission lines extend north to south through the middle of Bridle Trails and a gravel road generally follows the power lines through Bridle Trails. The Pike's Peak Reservoir site and surrounding areas were visited by RH2 on July 8, 2010. If this site is selected, the City would prefer to demolish the existing Pikes Peak Reservoir and construct a new reservoir at the same location as the existing reservoir. Notes and photos from the site reconnaissance are shown in **Appendix D** and a schematic site plan for the proposed reservoir is shown in **Figure 6**.

Site Access

Access to the existing reservoir site is located within an existing water utility easement north of NE 39th Street, at the south side of Bridle Trails. Access at this location is along an existing gravel driveway enclosed by two 4-foot-tall, 11-½ foot wide, locked cedar gates.

Adjacent Structures

The existing 24-foot-tall, 85-foot-diameter steel Pike's Peak Reservoir and booster pump station are located immediately north of single-family residential homes along NE 39th Street. An existing Seattle City Light steel overhead power line tower is located southwest of the existing Pike's Peak Reservoir.

Topography and Capacity Availability

The Pike's Peak Reservoir site is relatively flat, with elevations ranging from 532 feet to 536 feet based on the 1968 Pike's Peak Reservoir site plan and should be confirmed during predesign. The ground elevations do not pose any restrictions on the height of the reservoir. The full additional 6.5 MG in needed storage could be constructed on this site.

Geology

The Pike's Peak Reservoir site is mapped by the USGS as glacial till. A previous report, *Reservoir Seismic Upgrades Project*, HWA, 1998a, included shallow hand-auger borings to 3 feet below grade surface (BGS) to inspect soil and included six 15-foot BGS soil borings from previous investigations. Soil borings encountered dense silty sand with gravel (till) and dense silty sand (outwash).

Slopes

There is no field evidence for slope instability (steep slopes, ground cracks or tilted vegetation) at the proposed reservoir site. HWA (1998a) concluded the proposed reservoir site is at low risk for slope failure. The slopes at the reservoir site are relatively flat, are not susceptible to erosion and have a low potential for flooding. No steep slopes or slope breaks are apparent in LIDAR imagery at the Pike's Peak Reservoir site.

Soils and Wetlands

The Pike's Peak Reservoir site is mapped by the NRCS as Alderwood soil, derived from glacial till. The soils west of the reservoir site are erosion-prone soils, as identified by iMAP, although the proposed reservoir parcel itself is not identified as having erosion hazards. The locations of erosion-prone soils near the Pike's Peak Reservoir site are shown in **Figure 6**. No other critical or sensitive areas were observed during site reconnaissance or are shown at the proposed reservoir site by iMAP.

An unidentified creek flows north to south in the northwestern corner of the Bridle Trails parcel, located approximately 0.7 miles northwest of the proposed reservoir site. The National Wetlands Inventory (NWI) reports a small wetland within the Bridle Trails parcel approximately 0.5 miles northwest of the proposed reservoir site. No wetlands, hydrology or hydrophytic plant communities are mapped or were evident during site reconnaissance at the proposed reservoir site.

Seismic Vulnerability

HWA (1998a) concluded low risk for ground rupture and liquefaction at the Pike's Peak Reservoir site. The City has mapped the site as low seismic risk and low liquefaction risk.

Vegetation

The vegetation surrounding the existing Pike's Peak Reservoir primarily consists of mature coniferous forest including 12-inch-diameter and larger conifers and 3- to 8-foot-tall ferns, herbs and shrubs. The conifers are primarily 60 feet tall or taller and are spaced approximately 10 to 25 feet apart.

Permits and Approvals

The Bridle Trails State Park parcel is zoned R1 (Urban Residential). Reservoirs are a permitted use in the R1 zone. A pre-application conference is recommended based on the project's size and location within Bridle Trails. Moderate public interest is anticipated due to the proximity of the proposed reservoir site to single family homes and the popularity of Bridle Trails for recreational uses. Anticipated permits and approvals include King County Commercial Building, Clearing and Grading, drainage review, SEPA compliance, NPDES Construction Stormwater General Permit, project approval from DOH, and renegotiation of the City's use agreement with State Parks. The proposed reservoir site is not located within a section currently identified by DNR as containing natural heritage features. According to King County Code, utility developments are exempt from significant tree retention requirements. Locating the larger replacement reservoir at the location of the existing reservoir will help minimize the disturbance of existing trees. Project activities, including tree removal, may need to be reviewed and approved by Washington State Parks as the proposed project is located in Bridle Trails.

Neighborhood Impacts

The eastern portion of the proposed reservoir may be visible from a single-family residence facing the existing reservoir site.

Temporary construction noise may be audible to the adjacent single family residences. Construction activities may result in temporarily obstructed access along NE 39th Street and along the existing trails within Bridle Trails.

Geological and Environmental Conclusions and Recommendations

The proposed reservoir site's vulnerability to natural hazards is low. The soils at the proposed reservoir site are glacially over-consolidated, are at or near optimum moisture content, contain little or no organic soil, and are likely underlain by thick unsaturated geologic units. Constructability of a reservoir at this site is favorable as a result of these existing soil conditions and should require limited amounts of ground preparation.

The soil at the proposed reservoir site consists of low-permeability till and more permeable outwash, resulting in the soil having limited infiltration capacity. As a result, stormwater runoff or reservoir discharge will require conveyance to a nearby stormwater system or relatively large swales.

No geologic or natural hazard site conditions reduce the viability of the site for reservoir construction or operation.

Additional Water System Improvements

Hydraulic analyses were performed to determine the ability of the proposed Pike's Peak Reservoir to operate with the existing water system and to ensure adequate water supply can be conveyed from the reservoir to the major demand centers of the Bel-Red Corridor and the Central Business District, which will be located in a different pressure zone. The existing Pike's Peak Reservoir is supplied by gravity from the Seattle Public Utilities Tolt pipeline. As growth and infill occur, it is likely that the hydraulic grade of the Tolt pipeline will be drawn below 550 feet during periods of peak demand, requiring the City to utilize the existing 1,000 gpm Cherry Crest Pump Station to supply the Pike's Peak Reservoir. A new reservoir at the existing Pike's Peak Reservoir site will directly serve the Pike's Peak 550 Zone, similar to the current operation of the existing 1.0 MG reservoir. Currently, the Pike's Peak 550 Zone can transfer water to the Bellevue 400 Zone through PRV #116 located at 115th Avenue NE and approximately NE 35th Place, and PRV #49 in NE 24th Street, east of 131st Place NE.

A new reservoir at the Pike's Peak site will require the demolition of the existing Pike's Peak Reservoir as a new reservoir will be constructed in the same location with 4.5 MG of storage capacity. The existing booster pump station will not need to be moved or disturbed as part of the on-site construction activities. The transmission capacity from the proposed reservoir site to these PRVs, however, is inadequate to convey sufficient supply to the Bel-Red Corridor and the Central Business District in the Bellevue 400 Zone. Hydraulic analyses indicate that the relative hydraulic remoteness of a new reservoir at the Pike's Peak site to serve the Bellevue 400 Zone may not be fully utilized unless other improvements are also installed. Additionally, the City's operations staff have previously reported that adequate water turnover in the existing Pike's Peak Reservoir is difficult to achieve during periods of low demands. A new storage facility at this site without additional improvements will further exacerbate this concern.

For the purposes of the analyses, improvements were selected to achieve a minimum discharge rate from the reservoir in order to achieve complete turnover in a new reservoir at the Pike's Peak site in five days or less during periods of low demands. To enable the adequate transfer of water supply to the Bellevue 400 Zone from a new reservoir located at the Pike's Peak site and achieve adequate turnover in the new reservoir during periods of low demands, planning-level water system improvements were identified utilizing the hydraulic model. The improvements include installation of a new PRV to transfer water from the existing 16-inch transmission main to the existing 20-inch Bellevue 400 Zone water main in NE 24th Street. This includes installation of a short 16-inch water main to connect the Pike's Peak 550 Zone with the Bellevue 400 Zone. These improvements are necessary because the approximately 3,700 LF of 8-inch water main between the Pike's Peak Reservoir and PRV #116 is inadequate to transfer the required flow rate of water to the Bellevue 400 Zone at adequate pressures. These improvements are shown schematically in **Figure 4** and are necessary because the existing PRVs and water main connecting the Pike's Peak 550 Zone with the Bellevue 400 Zone are undersized to provide a sufficient flow rate to achieve adequate water turnover in the proposed Pike's Peak Reservoir during periods of low demand.

The analyses also identified the need to throttle supply to the West Operating Area at 3,500 gpm or less at the Bel-Red Intertie during periods of low demand. Additionally, the set point of the Cherry Crest PRV in NE 24th Street should also be reduced from its existing hydraulic grade of 392 feet to a hydraulic grade of 389 feet. The new PRV should be equipped with operational controls to ensure adequate turnover is achieved during periods of low demands. The Clyde Hill 390 Reservoir

operational controls should be adjusted to balance the usage of the reservoirs in the Bellevue 400 Zone and assist in achieving additional turnover in a new reservoir at the Pike's Peak site during periods of low demand. The higher demands in the summer months and other periods of peak demands will result in adequate turnover in all of the existing and proposed West Operating Area reservoirs without further adjustment of the existing control valve set points and without throttling of the Bel-Red Intertie.

Preliminary Cost Estimate

Project costs related to the proposed Pike's Peak Reservoir and other improvements associated with the construction of a reservoir at this site were estimated based on costs of similar water projects in the Puget Sound area and are presented in 2010 dollars in **Table 4**.

Table 4
Proposed Pike's Peak Reservoir Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
	Construction Costs (2010 $$)				
1	4.5 MG Reservoir (3.5 MG Net Increase)	LS	1	$ 3,375,000	$ 3,375,000
2	Site Work and Utilities	LS	1	$ 337,500	$ 337,500
3	Demolish Existing 1.0 MG Reservoir	LS	1	$ 150,000	$ 150,000
4	16-inch Water Main	LF	250	$ 180	$ 45,000
5	PP550/BV400 PRV	EA	1	$ 70,000	$ 70,000
	Construction Cost Subtotal				**$ 3,977,500**
	Washington State Sales Tax (9.5 percent)				$ 378,000
	Construction Cost Contingency (20 percent)				**$ 872,000**
	Construction Cost Total				**$ 5,227,500**
	Indirect Costs (2010 $$)				
	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 1,830,000
	Indirect Cost Total				**$ 1,830,000**
	Project Cost Subtotal				$ 7,057,500
	Project Contingency (5 percent)				$ 353,000
	Project Cost Including Construction and Indirect Costs				***$ 7,410,500***

In addition to the capital costs shown in **Table 4**, the net present value was estimated for the proposed Pike's Peak Reservoir improvements including preventative maintenance and reservoir recoating. The estimated net present value of the life cycle cost of the improvements is approximately $8,900,000, as shown in **Appendix B**.

Watershed Park Site

Background

Watershed Park (the Park) encompasses approximately 77 acres of undeveloped, mostly forested land in the City of Kirkland's Central Houghton Neighborhood. The City is interested in locating a proposed reservoir in the flat, open, southeastern portion of the Park that has been previously excavated and used as a borrow pit during construction of Interstate 405. The Park has multiple dirt and gravel walking trails for recreational uses. Public access is located in the northwest corner of the Park at the intersection of 110th Avenue NE and NE 45th Street. Construction or operation access

from this location will most likely not be permitted by the City of Kirkland as it would impact an ecologically valuable area of the Park. The Park was visited by RH2 on July 8, 2010. Based on field reconnaissance, the southwest corner of the flat, southern open area of the Park is the most favorable location for a proposed reservoir. Notes and photos from the site reconnaissance are shown in **Appendix C** and the favorable proposed reservoir location is shown in **Figure 7**.

Site Access

The Park is located north of State SR 520 and immediately west of Interstate 405 in the Central Houghton Neighborhood. There is no current vehicular access to the site. Nor does the site abut a viable public right of way or easement. Walking access to the Park exists through a portion of undeveloped land southeast of Watershed Park via a narrow, 2-foot-wide dirt trail north of the Yarrowood Highlands asphalt parking lot. This undeveloped portion of the Yarrowood Highlands property is located within the City of Bellevue's municipal boundary.

Pedestrian access to the Park also exists through the northern portion of a parcel located west of the Park. Access at this location is via an existing 2-foot-wide dirt trail along the northern edge of the existing multi-family residential building and immediately south of an existing steep downward slope.

Construction, operation and maintenance access to the proposed reservoir may be favorable from the Yarrowood Highlands property with the construction of an access driveway from the northern extents of the existing asphalt parking lot to the Park. Vehicular access to the proposed reservoir site will also require widening a portion of the existing gravel trail in the Park. The proposed site access location is shown in **Figure 7**.

Adjacent Structures

The Yarrowood Highlands multi-family residential buildings are located to the southeast of the proposed reservoir site and adjacent to the proposed reservoir site access. Single family residential homes within an existing development are located south of the proposed reservoir site with an existing 12-foot-tall concrete retaining wall along the northern and eastern extents of the development. Two multi-family residential buildings are located on the parcel west of the proposed reservoir site. No existing structures were observed within the southern portion of the Park.

Topography and Capacity Availability

The proposed reservoir site is flat and located in a broad, open basin that has been previously excavated and used for borrow material. The open basin is surrounded by a forested berm on all sides. Ground elevations at the favorable reservoir location are approximately 370 feet which would result in a reservoir height of approximately 30 feet. Ground elevations are based on 10-foot contours created from a digital elevation map and should be confirmed during predesign. The full 6.5MG in needed storage can be constructed on this site.

Geology

The Park's proposed reservoir site is mapped by the USGS as glacial till. No previous geological reports exist for the proposed reservoir site.

Slopes

There is no field evidence for slope instability (steep slopes, ground cracks or tilted vegetation) at the proposed reservoir site. The site is reportedly not subject to severe landslide risk based on King County Sensitive Areas Ordinance mapping. The slopes at the proposed reservoir site are relatively flat, are not susceptible to erosion and have a low potential for flooding. No steep slopes or slope breaks are apparent in LIDAR imagery at the Park's proposed reservoir site. Steep slopes and erosion-prone soils exist north of the site in the unnamed stream channel shown in **Figure 7**, but at a sufficient distance to minimize the risk of slope instability at the proposed reservoir site.

Soils and Wetlands

The Park's proposed reservoir site is mapped by the NRCS as Alderwood soil, derived from glacial till. The soils approximately 0.2 miles northwest of the proposed reservoir site are erosion-prone soils as identified by iMAP, although the proposed reservoir site itself is not identified as having erosion hazards. The locations of erosion-prone soils near the Park's proposed reservoir site are shown in **Figure 7**. No other critical or sensitive areas were observed during site reconnaissance or are shown at the proposed reservoir site by iMAP.

Yarrow Creek is located approximately 0.2 miles northwest of the proposed reservoir site and would not be impacted during construction of the proposed reservoir. The City of Kirkland Sensitive Areas map shows Yarrow Creek as the only critical area within Watershed Park. No wetlands, hydrology or hydrophytic plant communities are shown in NWI data or are evident from site reconnaissance at the proposed reservoir site.

Seismic Vulnerability

The City has mapped the site as low seismic risk and low liquefaction risk.

Vegetation

The vegetation in the flat open basin at the proposed reservoir site primarily consists of invasive herbs such as Scotch broom, Dalmatian toadflax, thistle and St. Johns wort, as well as grass, shrubs and some volunteer tree saplings. Portions of the proposed reservoir site have recently undergone some reforestation planting, and the southeastern corner of the parcel appears to be undergoing natural reforestation.

Plant species in the forested berm surrounding the proposed reservoir site are Himalayan blackberry, black cottonwood, Douglas fir, Western red cedar and Western hemlock.

Permits and Approvals

The Park's parcel is zoned as Park/Open Space (P). A reservoir is a permitted use at this location at the time of this review. No City of Kirkland Zoning Code review process is required for public utility uses within this zone. Structure height, lot coverage and setbacks are determined on a case-by-case basis by the City of Kirkland. A pre-application conference is recommended, based on the project's size and location within the Houghton Neighborhood and the Park. Moderate public interest is anticipated from Houghton Neighborhood residents and the Houghton Community Council. Anticipated permits and approvals include Commercial Building, Land Surface Modification, SEPA compliance, Clearing and Grading, NPDES Construction Stormwater General

Permit and project approval from DOH. The proposed reservoir site is not located within a section currently identified by DNR as containing natural heritage features.

Neighborhood Impacts

Site access for construction, operation and maintenance could be obtained through the northeastern side of the Yarrowood Highlands property. Construction noise could disturb these residents and the residents of the single family residential homes west of the undeveloped portion of the Yarrowood Highlands property. Existing Yarrowood Highlands parking spaces, which appear to be used for large vehicles, boats and trailers, may be temporarily blocked or otherwise impacted during construction and staging, especially during the mobilization and initial clearing phases of construction.

One single family home in the existing development immediately to south of the proposed reservoir site has one window facing the Park's flat, open area and the proposed reservoir would be directly visible from this window.

Access to the existing gravel walking trail along the Park's southern property line may be temporarily or permanently rerouted during construction of the proposed reservoir and the reservoir access driveway. The proposed reservoir and access driveway can be located to minimally impact the location of the Park's existing gravel walking trails.

Existing deciduous and coniferous trees over 100 feet tall within the Park obstruct the view of other existing residences to the open, flat area of Watershed Park where the proposed reservoir could be located.

Geological and Environmental Conclusions and Recommendations

The site's vulnerability to natural hazards is low. The soils at the proposed reservoir site are glacially over-consolidated, are at or near optimum moisture content, contain little or no organic soil, and are likely underlain by thick unsaturated geologic units. Constructability of a reservoir at this site is favorable as a result of these existing soil conditions and should require limited ground preparation.

The soil at the proposed reservoir site consists of low-permeability till. As a result, the soil's infiltration capacity is limited and stormwater runoff or reservoir discharge will require conveyance to a nearby stormwater system or relatively large swales.

No geologic or natural hazard site conditions reduce the viability of the site for reservoir construction or operation. However, the subsurface condition is unknown because the site was previously excavated for borrow, but it likely consists of some glacial till and dense advance outwash sand. A soil boring is recommended to confirm these conditions.

Additional Water System Improvements

Hydraulic analyses were performed to determine the ability of the proposed Watershed Park Reservoir to operate with the existing water system and to ensure adequate water supply can be conveyed from the reservoir site, which is hydraulically remote from the major demand centers of the Bel-Red Corridor and the Central Business District. A new reservoir located in Watershed Park can serve the Bellevue 400 Zone by constructing a new transmission main to connect the reservoir site to the zone. The water main alignment shown in **Figure 4** includes the installation of

approximately 3,050 feet of new 12-inch water main from the reservoir site, southeast to the existing 12-inch water main in 108th Avenue NE.

For the purposes of the analyses, improvements were selected to achieve a minimum discharge rate from the reservoir in order to achieve complete turnover in a new reservoir at Watershed Park in five days or less during periods of low demands. To enable the adequate transfer of water supply to the Bel-Red Corridor and the Central Business District from a new reservoir located at Watershed Park and achieve adequate turnover in the new reservoir during periods of low demands, planning-level water system improvements were identified utilizing the hydraulic model.

The existing Bellevue 400 Zone water main in the vicinity of Watershed Park is comprised of 8-inch, 10-inch and 12-inch water main which is sufficient to meet the flow requirements of the system with adjustment of the control valve settings at the Clyde Hill 390 Reservoir and the Bel-Red Intertie. Additionally, the set point of the Cherry Crest PRV in NE 24th Street should be reduced from its existing hydraulic grade of 392 feet to a hydraulic grade of 388 feet. The Clyde Hill 390 Reservoir operational controls should be adjusted to balance the usage of the reservoirs in the Bellevue 400 Zone and to assist in achieving adequate turnover during periods of low demands in a new reservoir at the Watershed Park site. The higher demands in the summer months and other periods of peak demands will result in achieving adequate turnover in all of the existing and proposed West Operating Area reservoirs without further adjustment of the existing control valve set points and without throttling of the Bel-Red Intertie.

Alternative alignments may be considered in the predesign phase of the project if challenges are encountered in obtaining an easement through Watershed Park or the Yarrowood Highlands property. However, alternative alignments may require more extensive water main improvements and may require multiple crossings of SR 520 and Interstate 405 to ensure that a reservoir located at this site is fully utilized.

Preliminary Cost Estimate

Project costs related to the proposed Watershed Park Reservoir and other improvements associated with the construction of a reservoir at this site were estimated based on costs of similar water projects in the Puget Sound area and are presented in 2010 dollars in **Table 5**.

Table 5
Proposed Watershed Park Reservoir Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
	Construction Costs (2010 $$)				
1	3.5 MG Reservoir	LS	1	$ 2,625,000	$ 2,625,000
2	Site Work and Utilities	LS	1	$ 262,500	$ 262,500
3	Drainage System Infrastructure Improvements	LF	1,500	$ 160	$ 240,000
4	16-inch Water Main	LF	3,050	$ 180	$ 549,000
5	Clearing for Site Access	LS	1	$ 50,000	$ 50,000
6	Crushed Surfacing for Site Access Driveway	LF	1,200	$ 105	$ 126,000
	Construction Cost Subtotal				**$ 3,852,500**
	Washington State Sales Tax (9.5 percent)				$ 366,000
	Construction Cost Contingency (20 percent)				**$ 844,000**
	Construction Cost Total				**$ 5,062,500**
	Indirect Costs (2010 $$)				
	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 1,772,000
	Purchase Land from City of Kirkland				$ 850,000
	Indirect Cost Total				**$ 2,622,000**
	Project Cost Subtotal				$ 7,684,500
	Project Contingency (5 percent)				$ 385,000
	Project Cost Including Construction and Indirect Costs				***$ 8,069,500***

The cost to purchase a portion of the Watershed Park parcel from the City of Kirkland identified in **Table 5** is an estimate based on the $9,800,000 assessed value of the parcel. The City of Bellevue will require an area of approximately 4.5 acres to construct the proposed 3.5 MG Watershed Reservoir. This equates to approximately 6 percent of the total parcel area, resulting in an approximate cost of $600,000 for the required 4.5 acres. A 40-percent contingency was applied to this starting basis resulting in an estimated cost of approximately $850,000 for the 4.5 acres of land necessary to construct the proposed 3.5 MG Watershed Reservoir. However, this cost is highly variable and may change significantly based on the terms of a future agreement between the City of Bellevue and the City of Kirkland.

The drainage system infrastructure improvements identified in **Table 5** are for connecting the proposed reservoir drain to the City's existing storm drainage system. Analyses to evaluate the flow capacity requirements for the storm drainage system are beyond the scope of this study.

In addition to the capital costs shown in **Table 5**, the net present value was estimated for the proposed Watershed Park Reservoir improvements including preventative maintenance and reservoir recoating. The estimated net present value of the life cycle cost of the improvements is approximately $9,200,000 in 2010 dollars, as shown in **Appendix B**.

Woodridge Reservoir Site

Background

The 2.0 MG steel Woodridge Reservoir is located on the north side of Woodridge Water Tower Park in the Richards Valley subarea. Landscaped trees, shrubs and grassy areas surround the existing reservoir, with gravel paths connecting the landscaped areas to a gravel parking lot on the south side of the parcel. The Woodridge Reservoir site was visited by RH2 on July 8, 2010. Based on field

reconnaissance, the flat grassy area east of the existing reservoir is the most favorable proposed reservoir location and the gravel parking lot is an alternative proposed reservoir location. The existing Woodridge Reservoir could be demolished and replaced with a larger reservoir. Notes and photos from the site reconnaissance are shown in **Appendix D** and the favorable proposed reservoir locations are shown in **Figure 8**.

Site Access

The Woodridge Reservoir site is bound by 123rd Ave SE to the west, SE 20th St to the south, and 125th Ave SE to the east. Existing access to the Woodridge Reservoir is located along the north side of the parcel at the intersection of 125th Avenue SE and SE 19th Street. Favorable construction, operation and maintenance access for a proposed reservoir at this parcel is at the same location as the existing access, or along SE 20th Street at the location of the existing gravel parking lot. Access via SE 20th Street may require significant earthwork should the proposed reservoir be constructed on the northern portion of the parcel because the south side of the parcel is approximately 30 feet lower in elevation than the north side of the parcel. The proposed site access locations are shown in **Figure 8**.

Adjacent Structures

The existing 2.0 MG, steel Woodridge Reservoir and a CMU block building are located within a chain link fenced area on the north side of the parcel. The 71-foot-tall Woodridge reservoir provides water storage for the City's Bellevue 400 Zone. One-story single family residential homes are located immediately west, north and east of the existing reservoir, with three parcels sharing a property line with the existing Woodridge Reservoir parcel. Woodridge Elementary School is located across SE 20th Street to the south.

Topography and Capacity Availability

The proposed reservoir site is flat and located on a broad summit with gentle slopes on all sides. Ground elevations at the Woodridge Reservoir site range from approximately 310 to 330 feet, thereby requiring a reservoir height of approximately 71 feet. The ground elevations are based on elevations from an undated proposed site grading plan and should be confirmed during predesign.

Approximately 1.5 MG to 2.0 MG of additional storage can be constructed on this site without demolition of the existing Woodridge Reservoir; possibly more. This will be impacted by permitting constraints such as setbacks, landscaping requirements, and neighborhood mitigation requirements. These constraints can be more fully vetted during a predesign phase. The Woodridge Reservoir site has available area to accommodate up to 6.5 MG of total storage if the existing reservoir were demolished.

Geology

The Park's proposed reservoir site is mapped by the USGS as glacial till. A previous report, *Reservoir Seismic Upgrades Project*; HWA, 1998b, included one 48-foot BGS soil boring which encountered dense silty sand with gravel (till) and dense silty sand (outwash). Previous test pits to 8 feet BGS by Harstad and Associates in 1955 encountered dense sand and "blue clay and gravel," which appears to indicate glacial till.

Slopes

There is no field evidence for slope instability (steep slopes, ground cracks or tilted vegetation) at the proposed reservoir site. HWA (1998b) concluded the Woodridge Reservoir site is at low risk for slope failure. The slopes at the proposed reservoir site are relatively flat, are not susceptible to erosion and have a low potential for flooding.

No steep slopes or slope breaks are apparent in LIDAR imagery at the Woodridge Reservoir site.

Soils and Wetlands

The Park's proposed reservoir site is mapped by the NRCS as Alderwood soil, derived from glacial till. No critical areas were identified during site reconnaissance or by iMAP at the existing Woodridge Reservoir site or adjacent parcels. The NWI and WDFW Salmonscape application show no wetlands or streams within or near the Woodridge Reservoir site. No wetlands, hydrology or hydrophytic plant communities were evident from site reconnaissance.

Seismic Vulnerability

HWA (1998b) concluded that the Woodridge Reservoir site is at low risk for ground rupture and liquefaction. The City has mapped the site as low seismic risk and low liquefaction risk.

Vegetation

East of the Woodridge Reservoir site is a small forested and grassy park with an extensive canopy cover. Vegetation throughout the site is primarily composed of landscaped deciduous trees and shrubs, with areas of grass divided by gravel walking paths.

Permits and Approvals

The Woodridge parcel is zoned R-3.5 (single-family residential, 3.5 dwellings per acre) and is currently a City park. Reservoirs are conditional uses in this zone. A pre-application conference is recommended based on the project's size and proximity to single family homes. Anticipated permits and approvals include a Conditional Use Permit (Land Use Permit Process I complete with public meeting and open-record hearing), building permit, Clearing and Grading, SEPA compliance, NPDES Construction Stormwater General permit and project approval from DOH. The proposed reservoir site is not located within a section currently identified by DNR as containing natural heritage features.

Neighborhood Impacts

Construction noise will be audible to single family residences adjacent to the Woodridge Reservoir site. The existing Woodridge Reservoir is visible to the existing single family homes in all directions over the tops of deciduous trees at the site. An additional reservoir at this site with a similar height would also be visible above the on-site vegetation and to adjacent single family residences. A single family residence located on the parcel immediately east of the existing Woodridge Reservoir site is located within 100 feet of the proposed reservoir site and has windows directly facing the existing reservoir site. Existing 20- to 50-foot-tall trees would likely need to be removed for construction of a new reservoir, resulting in increased visibility of the reservoir(s) throughout the City. The number of available parking spaces in the gravel parking lot may be reduced or completely eliminated if the proposed reservoir is located in the southwest portion of the parcel.

Geological and Environmental Conclusions and Recommendations

The proposed reservoir site's vulnerability to natural hazards is low. The soils at the Woodridge Reservoir site are glacially over-consolidated, are at or near optimum moisture content, contain little or no organic soil, and are likely underlain by thick unsaturated geologic units. Constructability of a reservoir at this site is favorable as a result of these existing soil conditions and should require limited amounts of ground preparation.

The soil at the proposed reservoir site consists of low-permeability till and more permeable outwash. As a result, the soil's infiltration capacity is limited and stormwater runoff or reservoir discharge will require conveyance to a nearby stormwater system.

No geologic or natural hazard site conditions reduce the viability of the site for reservoir construction or operation.

Additional Water System Improvements

Hydraulic analyses were performed to determine the ability of the proposed Woodridge Reservoir to operate with the existing water system and to ensure adequate water supply can be conveyed from the reservoir site, which is hydraulically remote from the major demand centers of the Bel-Red Corridor and the Central Business District. A new reservoir at the existing Woodridge Reservoir site will directly serve the Bellevue 400 Zone, similar to the current operation of the existing 2.0 MG reservoir. Currently, the existing reservoir is connected to the Bellevue 400 Zone by 12-inch and 16-inch water main.

In order to maximize the storage capacity of the site, a new reservoir at the Woodridge site will require the demolition of the existing Woodridge Reservoir. This will allow for the construction of a new reservoir up to a total capacity of 5.5 MG. The transmission capacity from the existing reservoir site, however, is inadequate to convey sufficient supply to the demand centers in the Bel-Red Corridor and the Central Business District. Hydraulic analyses indicate that the relative hydraulic remoteness of a new reservoir at the Woodridge site to serve the Bellevue 400 Zone may not be fully utilized unless additional improvements are installed.

For the purposes of the analyses, improvements were selected to achieve a minimum discharge rate from the reservoir in order to achieve complete turnover during periods of low demands in a new reservoir at the Woodridge site in five days or less. To enable the adequate transfer of water supply to the Bellevue 400 Zone from a new reservoir located at the Woodridge site and achieve adequate turnover in the new reservoir during periods of low demands, planning-level water system improvements were identified utilizing the hydraulic model. The improvements include replacing the existing 6-inch water main in SE 5th Street, between 118th Avenue SE and 116th Avenue SE, with 16-inch water main. This improvement is shown schematically on **Figure 4**.

The analyses also identified the need to throttle supply to the West Operating Area at 3,000 gpm or less at the Bel-Red Intertie. The set point of the Cherry Crest PRV in NE 24th Street should be reduced from its existing hydraulic grade of 392 feet to a hydraulic grade of 384 feet. The Clyde Hill 390 Reservoir operational controls should be adjusted to balance the usage of the reservoirs in the Bellevue 400 Zone and assist in achieving additional turnover during periods of low demands in a new reservoir at the Woodridge site. The higher demands in the summer months and other periods of peak demands result in achieving adequate turnover in all of the existing and proposed West

Operating Area reservoirs without further adjustment of the existing control valve set points and without throttling of the Bel-Red Intertie.

Preliminary Cost Estimate

Project costs related to the proposed Woodridge Reservoir and other improvements associated with the construction of a reservoir at this site were estimated based on costs of similar water projects in the Puget Sound area and are presented in 2010 dollars in **Table 6**.

Table 6
Proposed Woodridge Reservoir Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
	Construction Costs (2010 $$)				
1	5.5 MG Reservoir (3.5 MG Net Increase)	LS	1	$ 5,775,000	$ 5,775,000
2	Site Work and Utilities	LS	1	$ 577,500	$ 577,500
3	Demolish Existing 2.0 MG Reservoir	LS	1	$ 300,000	$ 300,000
4	16-inch Water Main	LF	650	$ 180	$ 117,000
	Construction Cost Subtotal				**$ 6,769,500**
	Washington State Sales Tax (9.5 percent)				$ 644,000
	Construction Cost Contingency (20 percent)				**$ 1,483,000**
	Construction Cost Total				**$ 8,896,500**
	Indirect Costs (2010 $$)				
	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 3,114,000
	Indirect Cost Total				**$ 3,114,000**
	Project Cost Subtotal				$ 12,010,500
	Project Contingency (5 percent)				$ 601,000
	Project Cost Including Construction and Indirect Costs				***$ 12,611,500***

In addition to the capital costs shown in **Table 4**, the net present value was estimated for the proposed Woodridge Reservoir improvements including preventative maintenance and reservoir recoating. The estimated net present value of the life cycle cost of the improvements is approximately $13,500,000 in 2010 dollars, as shown in **Appendix B**.

CONCLUSIONS

The four reservoir sites and their associated improvements were prioritized based on the site-by-site evaluation criteria to determine the most favorable reservoir sites. The evaluation criteria included the net present value of the life cycle cost for 3.5 MG of additional storage for each site and eight other criteria that are difficult to quantify monetarily, such as neighborhood impacts and site access. **Table 7** lists criteria that were established for prioritizing the four reservoir sites. The criteria encompass nine different categories, with a weight factor assigned to each category. The criteria given the most weight were net cost, vulnerability to natural hazards and impacts to system hydraulics.

Table 7
Reservoir Site Priority Ranking Criteria

Points	Category	Weight Factor	Weighted Points
	Net Cost		
3	Net Cost is 84% or Less of Average Net Cost of All Four Sites	5	15
2	Net Cost is 85-114% of Average Net Cost of All Four Sites	5	10
1	Net Cost is 115% or More of Average Net Cost of All Four Sites	5	5
	Impacts to System Hydraulics		
3	Proposed Improvements Greatly Enhance System Hydraulics	5	15
2	Impact to System Hydraulics is Negligible	5	10
1	Proposed Improvements Adversely Effect System Hydraulics	5	5
	Vulnerability to Natural Hazards		
3	Site has Low Vulnerability to Ground Rupture or Liquefaction	4	12
2	Site has Medium Vulnerability to Ground Rupture or Liquefaction	4	8
1	Site has High Vulnerability to Ground Rupture or Liquefaction	4	4
	Impact to Critical or Sensitive Areas		
3	Critical or Sensitive Areas Not Impacted by Proposed Improvements	3	9
2	Critical or Sensitive Areas Potentially Impacted by Proposed Improvements	3	6
1	Critical or Sensitive Areas Impacted by Proposed Improvements	3	3
	Permitting		
3	Low Permitting Efforts Anticipated	3	9
2	Medium Permitting Efforts Anticipated	3	6
1	Extensive Permitting Efforts Anticipated	3	3
	Neighborhood Impacts		
3	Neighborhood Not Impacted by Proposed Improvements	3	9
2	Neighborhood Temporarily Impacted by Proposed Improvements	3	6
1	Neighborhood Permanently Impacted by Proposed Improvements	3	3
	Site Access		
3	Site Access Currently Exists	3	9
2	Site Access can be Easily Created	3	6
1	Site Access Must be Created and Easements Must be Obtained	3	3
	Location of Adjacent Structures		
3	No Structures Adjacent to Proposed Site	2	6
2	Structures in Vicinity of Proposed Site	2	4
1	Structures Immediately Adjacent to Proposed Site	2	2
	Impact to Existing Vegetation		
3	Proposed Improvements have Minimal Impact to Existing Vegetation	2	6
2	Proposed Improvements have Medium Impact to Existing Vegetation	2	4
1	Proposed Improvements have Large Impact to Existing Vegetation	2	2

Net cost points were assigned based on the net present value of the 100-year life cycle costs of the improvements for each site. Impacts to system hydraulics points were assigned based on the proposed improvements' impacts to the system hydraulics of the West Operating Area for each site. The differences in impacts to the system hydraulics are minimal among the four proposed reservoir sites as a result of the additional water system improvements that have been proposed for each site. The resulting service pressures in the Bellevue 400 Zone remain relatively constant (within 5 pounds per square inch) for all proposed reservoir sites. With storage at Watershed Park, the Bellevue 400 Zone service pressures are projected to be the lowest among the four alternatives. As a result, Watershed Park was given the fewest points in the Impacts to System Hydraulics category. Vulnerability to natural hazards points were assigned based on seismic vulnerability for each site. Impact to critical or sensitive areas points were assigned based on the proposed improvements' impact to critical or sensitive areas for each site. Permitting points were assigned based on the anticipated level of permitting required to construct the proposed improvements for each site. Neighborhood impacts points were assigned based on the proposed improvements' impact on the surrounding neighborhood and existing or future land uses for each site. Site access points were assigned based on site accessibility for each site. Location of adjacent structures points were assigned based on the proposed improvements' proximity to adjacent structures for each site. Impact to existing vegetation points were assigned based on the impacts to existing vegetation each site.

The reservoir site priority ranking criteria were applied to each of the four reservoir sites and the weighted point totals are shown in **Table 8**.

Table 8
Reservoir Site Weighted Point Totals

Criteria	Meydenbauer	Pike's Peak	Watershed Park	Woodridge
Points				
Net Cost	1	3	3	1
Impacts to System Hydraulics	2	2	1	2
Vulnerability to Natural Hazards	3	3	3	3
Impact to Critical or Sensitive Areas	3	3	3	3
Permitting	3	2	1	3
Neighborhood Impacts	1	3	2	2
Site Access	2	3	1	3
Location of Adjacent Structures	1	3	3	1
Impact to Existing Vegetation	3	2	1	2
Weighted Points				
Net Cost	5	15	15	5
Impacts to System Hydraulics	10	10	5	10
Vulnerability to Natural Hazards	12	12	12	12
Impact to Critical or Sensitive Areas	9	9	9	9
Permitting	9	6	3	9
Neighborhood Impacts	3	9	6	6
Site Access	6	9	3	9
Location of Adjacent Structures	2	6	6	2
Impact to Existing Vegetation	6	4	2	4
Total	**62**	**80**	**61**	**66**

The results of the analyses indicate that the most favorable sites to construct an additional 6.5 MG (3.0 MG to 3.5 MG at each site) are the Pike's Peak and Woodridge sites. Due to the additional costs that would be incurred with the operation, maintenance and ongoing energy costs, the Meydenbauer site was excluded from further consideration. Additionally, due to the uncertainty involved with the terms of a future agreement between the City and the City of Kirkland to construct a reservoir at Watershed Park, as well as the results of the priority ranking criteria, the Watershed Park site was also excluded from further consideration.

Locating all 6.5 MG of storage at a single site would require significant capital and maintenance expenditures that are not projected to be necessary for at least 2030. Locating the additional storage at two sites as part of a phased approach allows the City to accelerate or delay the construction of additional storage to accommodate future demands. Additional hydraulic analyses were performed to identify planning-level water system improvements for the construction of a new 4.5 MG Pike's Peak Reservoir (3.5 MG net increase) to meet existing system demands, and a future 5.0 MG Woodridge Reservoir (3.0 MG net increase) based on the system-wide peak year 2050 demand conditions shown in **Table 2**. With the construction of a 4.5 MG reservoir at the Pike's Peak site, only 3.0 MG of additional storage is required. A 5.0 MG Woodridge Reservoir would then meet the West Operating Area's future storage requirement shown in **Table 1**, instead of the 5.5 MG reservoir shown in **Table 6**.

The existing Pike's Peak Reservoir currently requires approximately $1,000,000 in repairs, including seismic upgrades and deferred maintenance. Conversely, the existing Woodridge

Reservoir was recently seismically upgraded and has an estimated 50 years of useful life remaining. The proposed 4.5 MG Pike's Peak Reservoir is therefore scheduled for construction prior to the construction of the proposed 5.0 MG Woodridge Reservoir. Although the existing Woodridge Reservoir has an estimated 50 years of useful life, it is scheduled to be replaced in 2030 to correspond with the projected storage needs shown in **Table 1**.

The Pike's Peak site was allocated 0.5 MG more additional storage than the Woodridge site because there are fewer constraints on the Pike's Peak site and doing so will further delay demolition of the existing Woodridge Reservoir. The Pike's Peak site has fewer adjacent structures, the availability of a larger construction staging area and will have a minimal impact to the surrounding neighborhood. Baffles may be installed at the proposed 4.5 MG Pike's Peak Reservoir to limit the volume of surplus storage in the West Operating Area and to assist in achieving adequate reservoir turnover during periods of low demands. However, these reservoir capacities are variable and should be reviewed by the City during the predesign phase.

The additional water system improvements described in the Pike's Peak section of the site evaluation must be constructed at the same time as the proposed 4.5 MG Pike's Peak Reservoir. Following construction of the 4.5 MG Pike's Peak Reservoir, the proposed 5.0 MG Woodridge Reservoir can be constructed in the future to resolve the projected 2050 West Operating Area storage deficiency. Additional planning-level water system improvements were identified utilizing the hydraulic model. These improvements would enable the adequate transfer of water supply to the Bellevue 400 Zone from both new reservoirs and achieve adequate turnover in each reservoir during periods of high and low demands. The improvements needed for utilizing the increased storage capacity at the Woodridge Reservoir site include replacing the existing 6-inch water main in SE 5th Street, between 118th Avenue SE and 116th Avenue SE, with 16-inch water main. The analyses also identified the adjustment of the control valve settings at the Clyde Hill 390 Reservoir and revising the operational controls at the Bel-Red Intertie and the Cherry Crest PRV.

These control settings, primarily the Bel-Red Intertie, should be evaluated seasonally to ensure adequate supply is available to the system and adequate turnover is achieved in the City's reservoirs. Based on preliminary hydraulic analyses, the Bel-Red Intertie should be restricted to approximately 3,500 gpm during the winter months or periods of low demands and can be increased to a maximum of 7,000 gpm during the summer months or periods of peak demands. The higher demands in the summer months and other periods of peak demands will result in achieving adequate turnover in all of the existing and proposed West Operating Area reservoirs without further adjustment of the existing control valve set points and without throttling the Bel-Red Intertie. The Clyde Hill 390 Reservoir control valve should be set between 4,500 and 5,000 gpm and the Cherry Crest PRV should be adjusted to open when the hydraulic grade on the downstream side of the PRV is less than 389 feet. The proposed Bellevue 400 Zone PRV on NE 24th Street should be set to open when the hydraulic grade on the downstream side of the PRV is less than 392 feet. However, similar to the reservoir capacities, the control station settings are variable and should be reviewed by the City during the predesign phase.

Project costs related to the proposed 4.5 MG Pike's Peak and 5.0 MG Woodridge Reservoirs, and other improvements associated with the construction of the reservoirs at these sites, were estimated based on costs of similar water projects in the Puget Sound area and are presented in 2010 dollars in **Table 9**.

Table 9
Proposed 4.5 MG Pike's Peak and 5.0 MG Woodridge Reservoirs Preliminary Cost Estimate

Item	Description	Units	Quantity	Unit Price	Total Price
	Construction Costs (2010 $$)				
1	4.5 MG Pike's Peak Reservoir	LS	1	$ 3,375,000	$ 3,375,000
2	Pike's Peak Site Work and Utilities	LS	1	$ 338,000	$ 338,000
3	Demolish Existing 1.0 MG Pike's Peak Reservoir	LS	1	$ 150,000	$ 150,000
4	5.0 MG Woodridge Reservoir	LS	1	$ 5,250,000	$ 5,250,000
5	Woodridge Reservoir Site Work and Utilities	LS	1	$ 525,000	$ 525,000
6	Demolish Existing 2.0 MG Woodridge Reservoir	LS	1	$ 300,000	$ 300,000
7	16-inch Water Main	LF	900	$ 180	$ 162,000
8	PP550/BV400 PRV	EA	1	$ 40,000	$ 40,000
	Construction Cost Subtotal				**$ 10,140,000**
	Washington State Sales Tax (9.5 percent)				$ 964,000
	Construction Cost Contingency (20 percent)				**$ 2,221,000**
	Construction Cost Total				**$ 13,325,000**
	Indirect Costs (2010 $$)				
	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 4,664,000
	Indirect Cost Total				**$ 4,664,000**
	Project Cost Subtotal				$ 17,989,000
	Project Contingency (5 percent)				$ 900,000
	Project Cost Including Construction and Indirect Costs				***$ 18,889,000***

In addition to the capital costs shown in **Table 9**, the net present value was estimated for the proposed 4.5 MG Pike's Peak and 5.0 MG Woodridge Reservoir improvements including preventative maintenance and reservoir recoating. The estimated net present value of the life cycle cost of the improvements is approximately $17,300,000 in 2010 dollars, as shown in **Appendix B**.

APPENDICES

APPENDIX A

Figures 1 through 8

APPENDIX B

Life Cycle Cost Analyses

APPENDIX C

Viable Site Identification Data

APPENDIX D

Site Reconnaissance Notes and Photos